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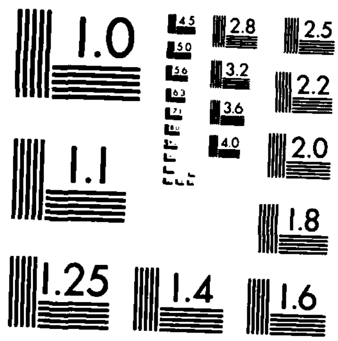

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Multiobjective Hierarchical Decision Problems in C^3, III

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Two main lines of research were pursued under the support of this grant. The first one was the study of control laws in the presence of many controllers, each one of which has his own objective and information, the decisions of each one influence the information and objectives of the others and where the controllers ignore several of the parameters involved in the description of the system equation and objectives. Ideas from both Adaptive Control and Game Theory were combined in developing adaptive schemes for each controller, so that the behavior of the system gets closer and closer, as time goes by to the one that would result in the known parameter case. The results obtained were reported in [1-5,9]. The second one concerns two more classical game problems [6-8]. In [6] the optimal shooting policy on a target that tries to escape, and in [7,8] the optimal flashing policies of two opponents involved in a duel were studied.

In [2] a dynamical system described by an AR model with two controllers, each one having his own target requirement was considered. The parameters of the system are unknown to the controllers, who at each instant of time know the previous history of the state and of their own decisions, but not the previous decisions of the other. In [3] the controls of the controllers are also penalized, whereas in Chapter III of [4] the more general ARMAX case is stsudied with similar information patterns as in [2]. Both stochastic and deterministic cases are considered and adaptive control laws are created. It is shown -- under some assumptions -- that as time goes by, the behavior of the systems resulting from the employed adaptive laws gets closer and closer to the one of the known parameter case. Two important issues surface in this research. One is that the estimation schemes used, which provide estimates used by the adaptive laws, should

pertain to time varying systems, although the system is time invariant. This is basically due to the fact that each controller is essentially faced with a time varying system due to his ignorance of the other controller's actions. The other issue pertains to the case where there are delays of the controls in the state equation (ARMAX case). There, the controllers have to consider a number of parameters to be estimated which is larger than the number of the unknown parameters of the real system. This is essentially due to the combination of the two facts: the ignorance of the other controller's actions and the presence of delayed controls. In Chapter IV of [4] an adaptive zero sum game was considered where the cost is the usual summation of quadratics. The adaptive schemes employed were shown to yield a stable closed loop system. In [1,9] two static cases were considered, where the controllers do not have knowledge of the other's cost parameters and information. In [1] adaptive schemes are exhibited which converge to the Nash solution of the known parameter case, whereas in [9], adaptive schemes are considered in a Nash set-up, which nonetheless lead to Pareto solutions. Publications [6-8] deal with two more classical zero sum-games. In [6] an enemy moves among certain positions and the objective is to find an optimal shooting policy. This enemy is not supposed to have shooting capability. In [7,8], both players have the ability to shoot ("flash"), but a failed use of the flash reveals the position of the one who flashed -- initially they do not know each other's positions. Optimal strategies were shown to exist, and were derived and studied.

Several of the results described above were presented in the conference papers [2,5,7,9] and the invited talks [10].

Publications Acknowledging the Support of This Contract

1. "Iterative Techniques for the Nash Solution in Quadratic Games with Unknown Parameters," to appear in SIAM Journal on Optimization and Control, 1986.

2. "On a Class of Decentralized Discrete Time Adaptive Control Problems," with W. Y. Yang, 24th IEEE Conf. on Decision and Control, Ft. Lauderdale, Florida, December 1985.

3. "Decentralized Adaptive Control in a Game Situation for Discrete-Time, Linear, Time Invariant Systems," with W. Y. Yang, March 1986.

4. "Decentralized Adaptive Control in a Game Situation for Discrete-Time, Linear, Time Invariant Systems," W. Y. Yang, Ph.D. Thesis, Dept. of EE-Systems, Univ. of Southern California, June 1986.

5. "Adaptive Games," 4th BiBos Symposium on Random Processes and Industrial Applications, Bielefeld University, FRG, April 1986.

6. "Rabbit and Hunter Game: Two Discrete Stochastic Formulations," with P. Bernhard and A. L. Colomb, to appear in Computers and Mathematics with Applications, Special Issue on Pursuit-Evasion Differential Games, 1986.

7. "On a Finite State Space Pursuit Evasion Game with Dynamic Information," with G. J. Olsder, invited for the 25th IEEE Conf. on Decision and Control, Athens, Greece, December 1986.

8. "A Markov Chain Game with Dynamic Information," with G. J. Olsder, June 1986.

9. "Adaptive Nash Strategies for Repeated Games Resulting in Pareto Solutions," G. J. Olsder, 1986 IFAC Workshop on Modelling, Decisions and Games, Beijing, August 1986.

10. Two invited talks on Adaptive Games in:

    * Dept. of Electrical Engineering, University of California at Santa Barbara, November 1985, and

    * Dept. of Mathematics, Katholieke Universiteit, Nijmegen, The Netherlands, Game Theory Day 4 (Topics in Adaptive Games), June 1986.

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